

# **Some reflections on Environment, Space and Alternative Energies**



**2011 International Workshop on Environment and Alternative Energy**

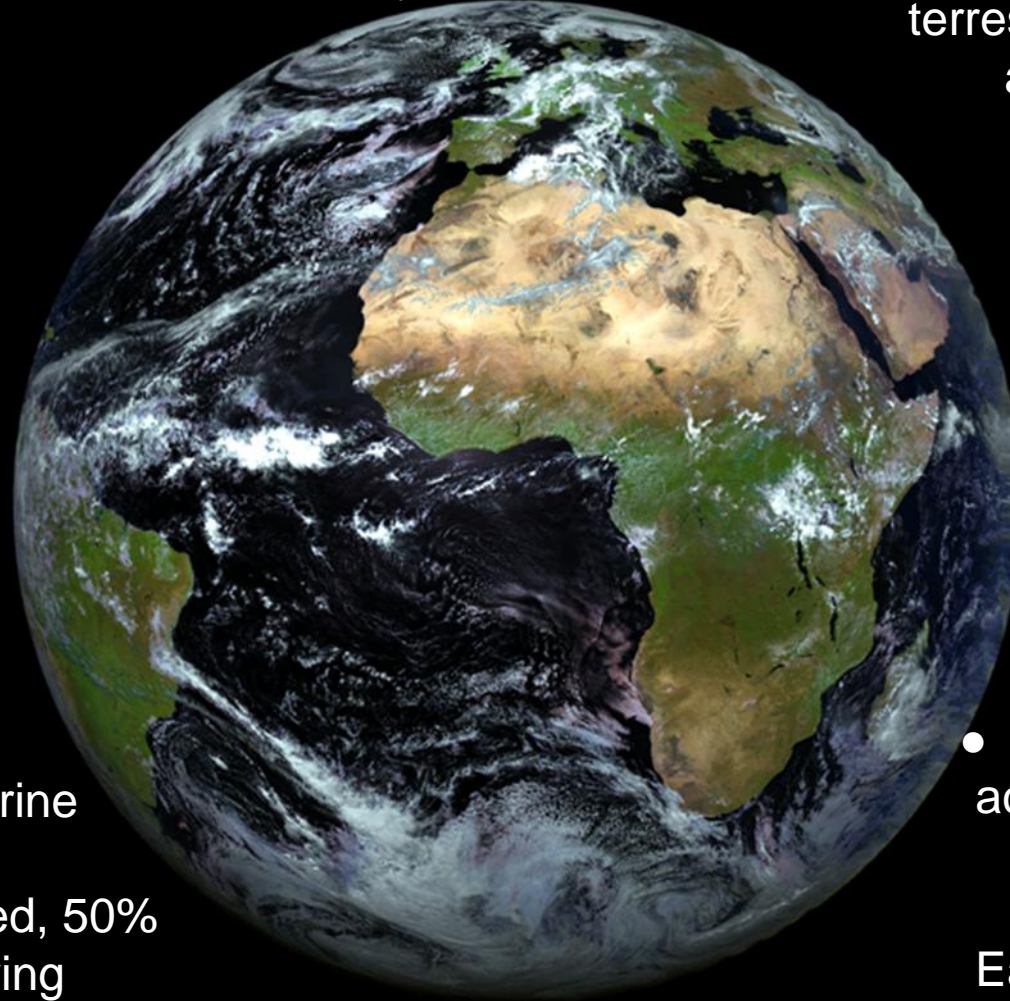
**ESTEC, 15-11-2011**

**Christer Fuglesang, ESA Astronaut**

**Head of Science and Application Division,  
Human Spaceflight and Operations Directorate**

- Within a few generations, humankind is likely to exhaust the fossil-fuel energy resources that were formed over several hundred million years.

- Species extinction rates are rising sharply in marine and terrestrial ecosystems around the world.



- As a consequence, atmospheric greenhouse-gas concentrations have risen far beyond the maxima reached during the last million years at least.

- Human action has transformed almost half of Earth's land surface, with significant consequences for biodiversity and climate.

- Coastal and marine habitats are being dramatically altered, 50% of mangroves having been removed, wetlands having shrunk by half.

- Tropical forest areas have been reduced by 50%.

- More than half of all accessible freshwater (less than 3% of the water available on Earth) is used directly or indirectly by humankind.





*“We went to explore the Moon,  
and in fact discovered the Earth”*

Eugene Cernan, Apollo-17 Commander



*When you fly in space....*

mostly you see Earth in blue and white





*...but the Earth is green also...*

Uruguay river flowing into Rio de la Plata



*...and then changing to red*



Mount Arkenu, Libya

An aerial photograph of a vast, high-altitude landscape, likely a tundra or alpine region. The terrain is a mix of brownish-yellow and greyish-brown, with numerous small, dark, irregular patches scattered across it. Several prominent, snow-capped mountain peaks are visible, particularly in the lower half of the image. Long, dark, and somewhat parallel shadows stretch across the landscape, suggesting a low sun position. The overall scene is one of a remote, rugged, and cold environment.

*Or yellow-brown*

Sajama (Bolivia) and Lauca (Chile) National Parks



*Fascinating colors and shapes in the oceans*



Elizabeth Reef, Tasman Sea



*Occasionally human constructions are recognizable*



A reservoir in Cameroon,  
near the Mbam River



*But night times  
there are  
thousands of dots  
of lights from  
cities*



Southern Italy




*No borders are seen  
from space!*

The Red Sea



*The atmosphere looks so  
fragile!*





**Space is ideal for  
studying weather,  
climate and human  
influence**



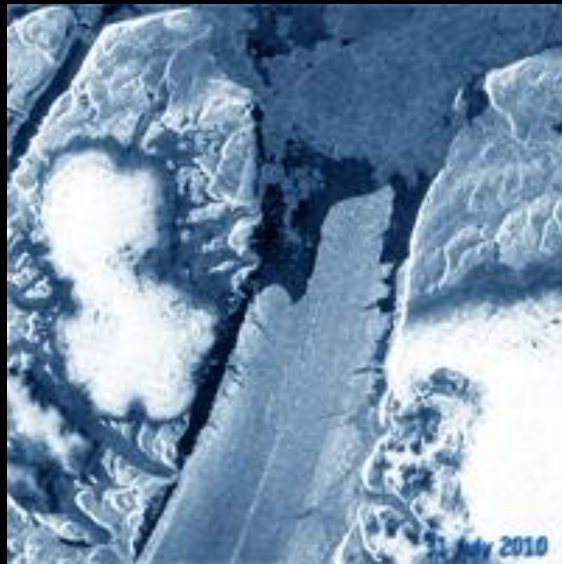
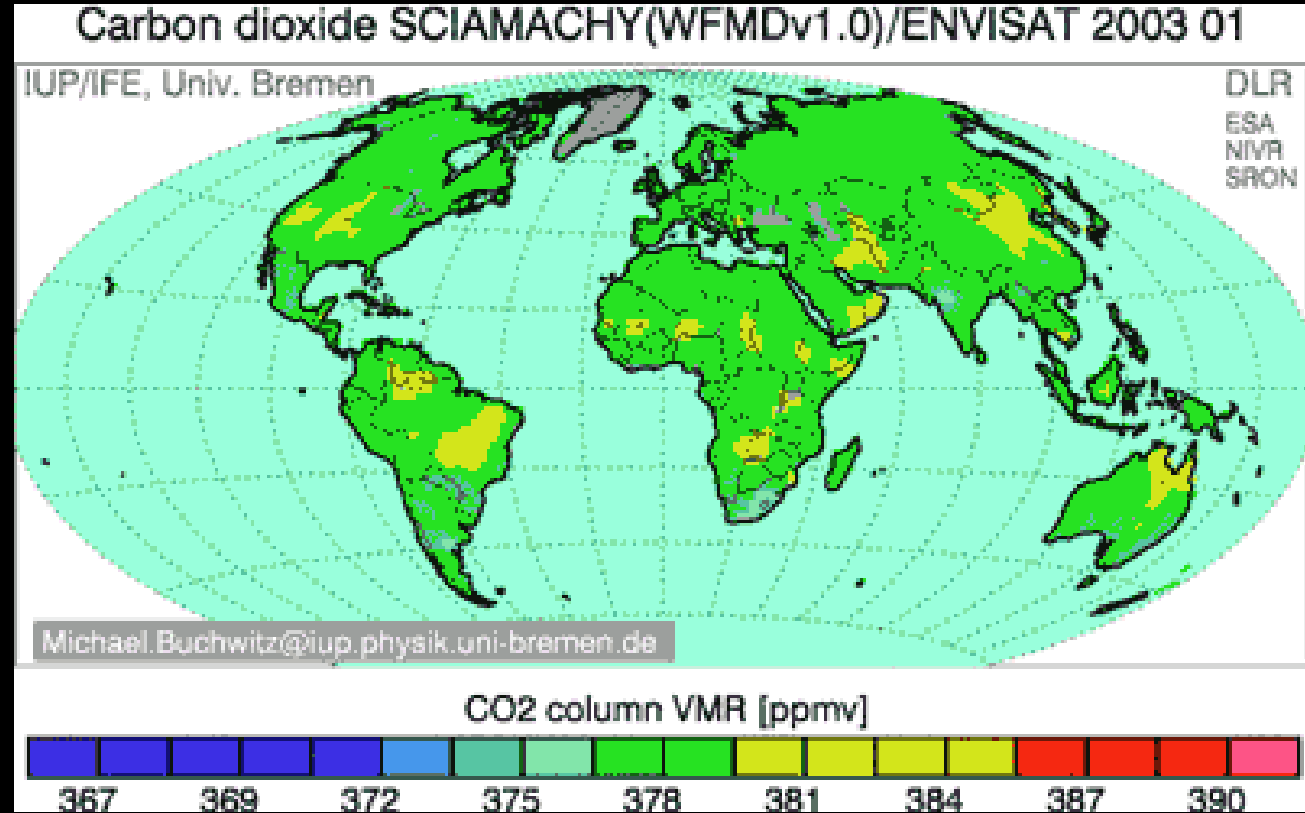
# Space to promote a sustainable development of Earth



“Travel Picture of the Year, 2006”



## Many dedicated Earth obs and environmental satellites



## CO<sub>2</sub> (carbon-dioxid) level month by month from 2003 to 2005



# ISS - the International Space Station

Orbit: 350-400 km altitude

51.6° inclination

Power: 80 kW

Normal atmosphere

Crew: 6



First part launched 1998

Permanently manned since November 2000



# Climate Change Studies from ISS



AO closed on 4/11. 16 proposals with 300+ investigators.  
Co-op HSO (within ELIPS program) + EOP Directorates.



- **ASIM:** *The Atmosphere Space Interaction Monitor payload will study giant electrical discharges (lightning) in the high-altitude atmosphere above thunderstorms and their role in the Earth's climate.*



- **ICARUS:** *International projects of bird migration tracking*

For Official Use



Living in space: Carefully monitor your space ship's environment  
BUT Earth is all humankind's space ship in the Universe!





# Use Clean Energy and Recycle!

100% Solar power

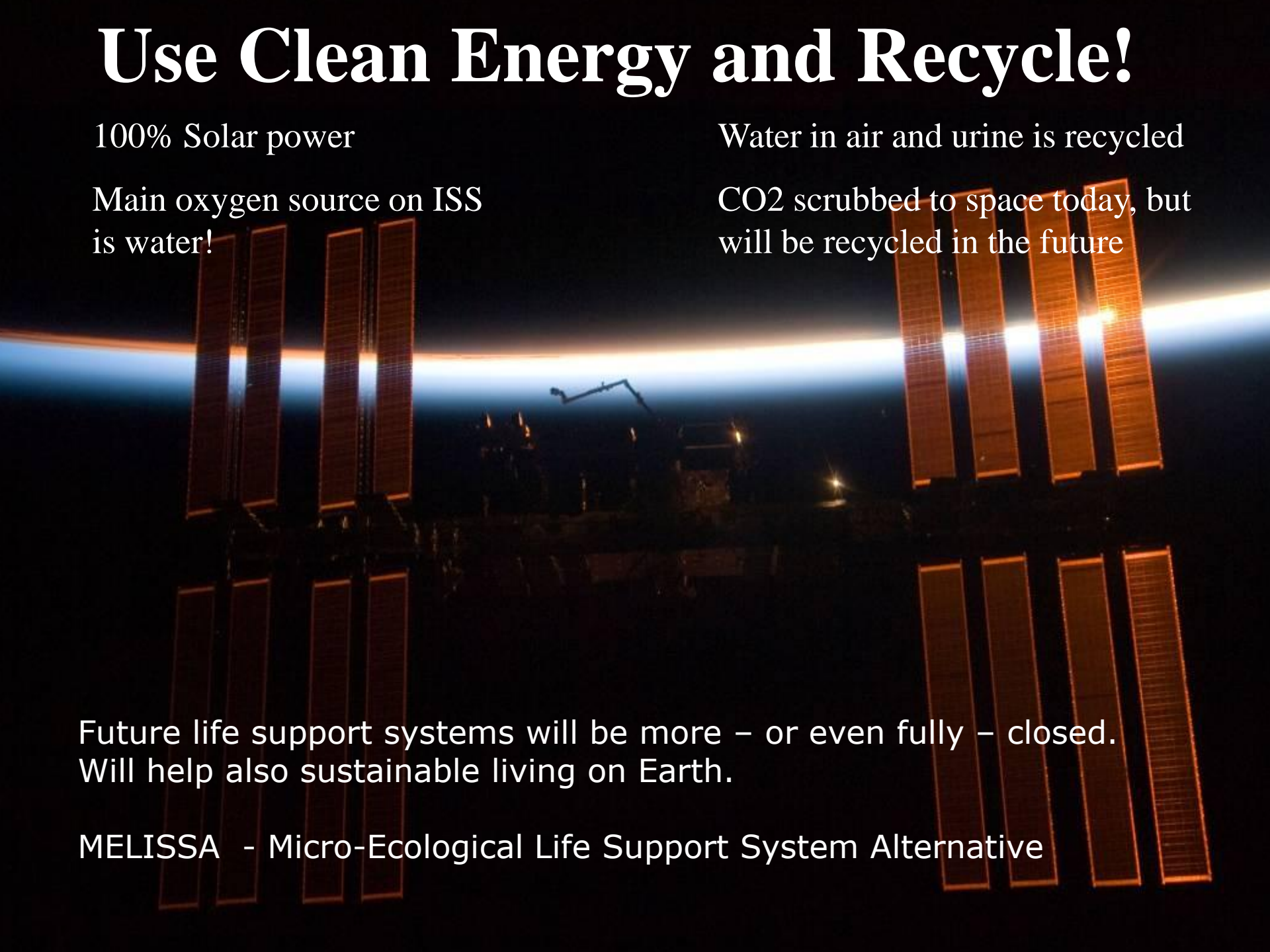
Main oxygen source on ISS  
is water!

Water in air and urine is recycled

CO<sub>2</sub> scrubbed to space today, but  
will be recycled in the future

Future life support systems will be more – or even fully – closed.  
Will help also sustainable living on Earth.

MELISSA - Micro-Ecological Life Support System Alternative









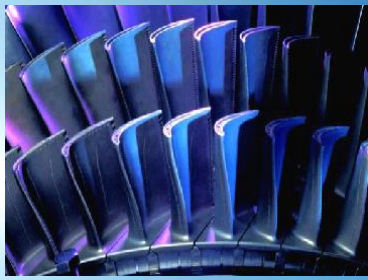

$$\text{CO}_2 = P \times S \times E \times C$$

PEOPLE      SERVICES PER PERSON      ENERGY PER SERVICE      CO<sub>2</sub> PER UNIT ENERGY



Efficiency & Renewables





# **RESEARCH ON MATERIALS & ENERGY IN THE CONTEXT OF ESA's ELIPS PROGRAMME**



**Christer Fuglesang, David Jarvis, Olivier Minster**

**Science and Applications Division  
Astronauts & Utilisation Department  
Directorate of Human Spaceflight and Operations**

# GENERAL OBJECTIVE

Support and accelerate the transfer of  
**knowledge** generated by research in space  
**into industrial processes** or products

The beautiful Earth, from 339 km above the North Atlantic Ocean, on Sep 8, 2009



# **The Role of Materials, Nanotechnology & $\mu\text{g}$ ?**

**Fuel-saving lightweight alloys and composites**

**High-temperature metallic alloys for power systems**

**Energy-harvesting thermoelectric nanocomposites**

**Magnetic and magnetocaloric materials**

**Superconducting alloys and compounds**

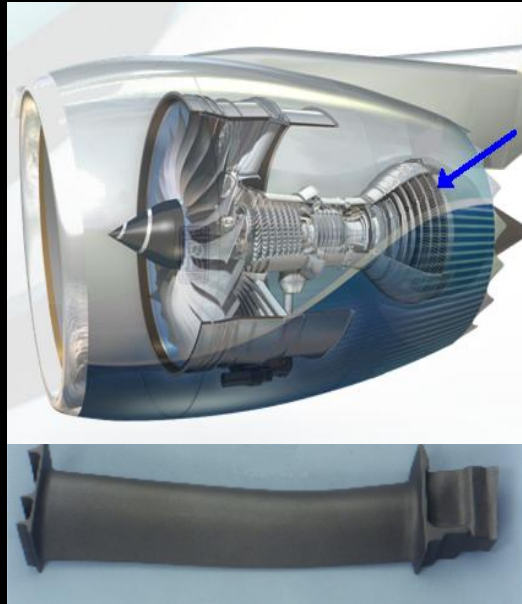
**Photovoltaic and solar-thermal materials**

**Corrosion-resistant more-durable materials**

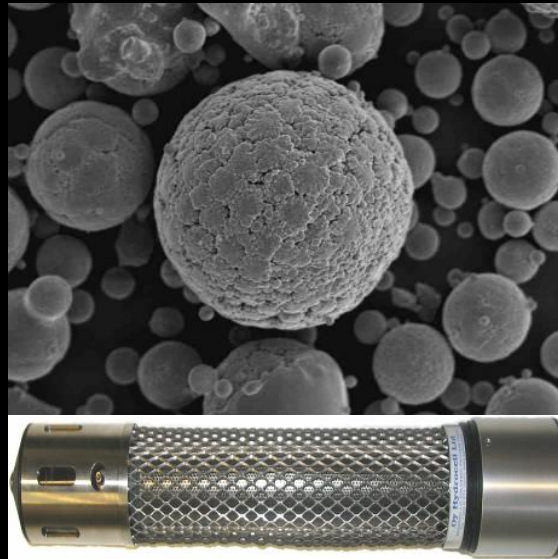
**High-efficiency catalysts and electrodes**

**Sustainable cost-affordable manufacturing**

**Energy-efficient recycling processes**



- **New lightweight TiAl** turbine blades for jet engines and gas



- **New NiAl** catalytic powders for hydrogen fuel cells and other chemical processes





# New Materials & Energy



**Next-generation of projects beyond IMPRESS, includes:**

**Accelerated Metallurgy** – world's first project on 'combinatorial alloy design' ✓ 22M€

**ThermoMag** – novel thermoelectric alloys for energy harvesting and for RTGs ✓ 6M€

**Colts** – casting of large titanium structures for space and aeronautics ✓ 6M€

**ExoMet** – ultra-lightweight Mg and Al nano-composite materials for aerospace ✓ 20M€

**Further projects on advanced heat exchangers for ground and space applications (fluid science + materials sciences)**

**These new projects benefit from ESA's investments in microgravity**

**All projects are inter-directorate within ESA in nature**

171





# **It's all about ENERGY!**

**Energy sources**

**Energy transformation**

**Energy carriers**

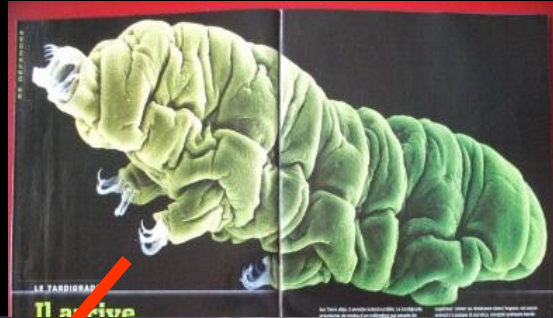
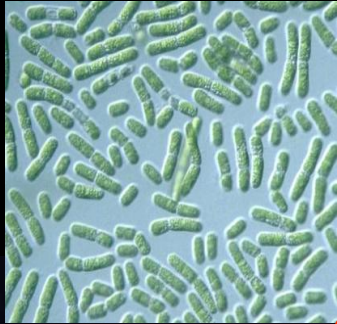
**With cheap energy sources and carriers, anything can be sustained and the environment protected.**

**Obtained by Research and Development –**

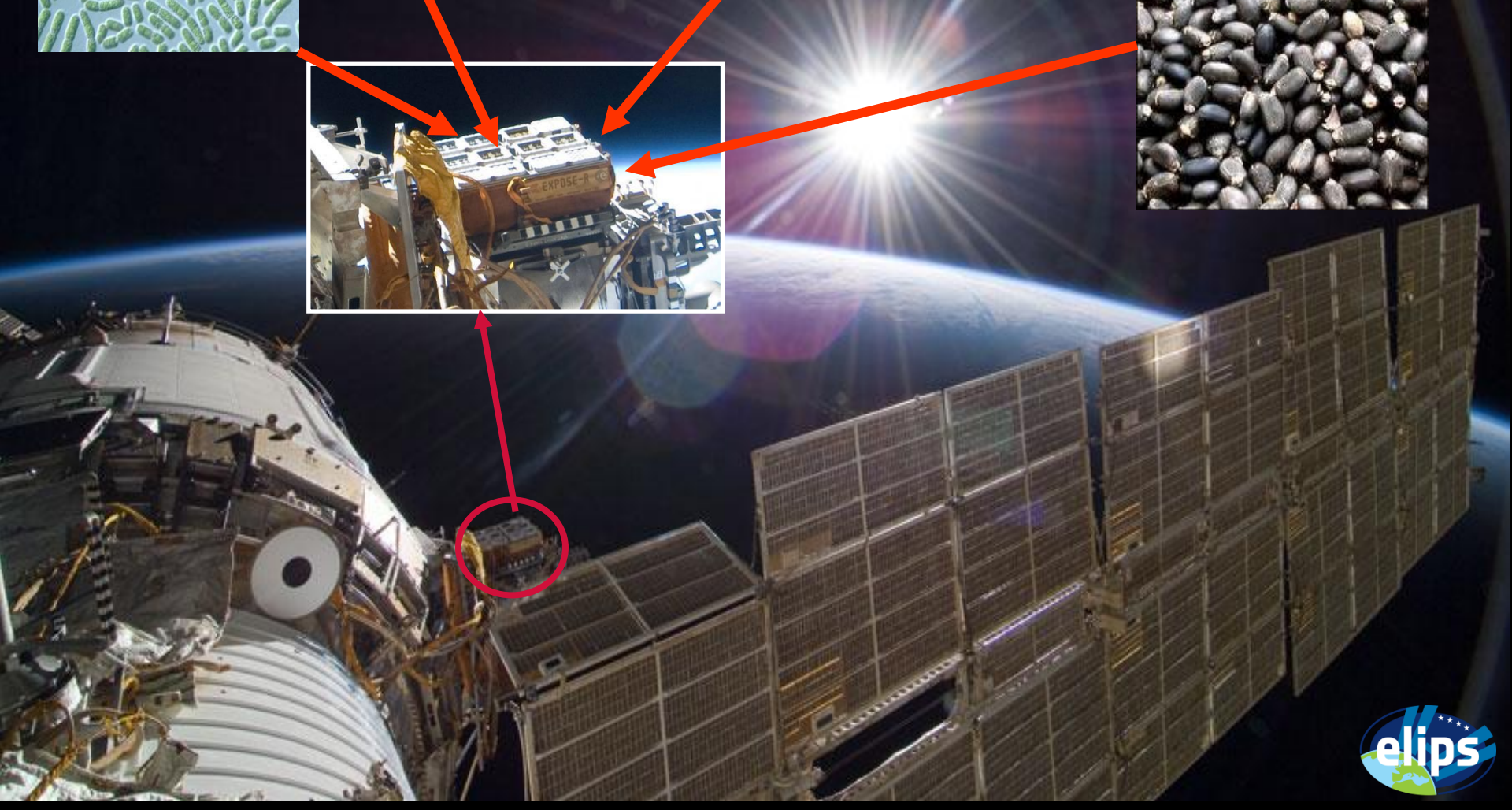
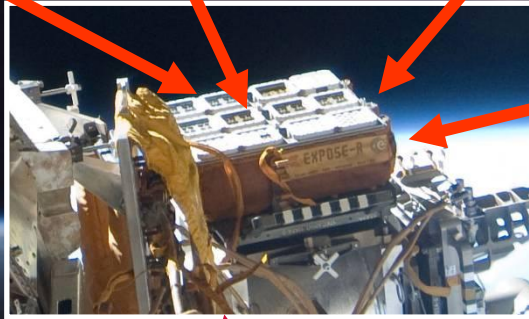
**But you can never predict where the breakthrough will come!**



# "Space Survivors"



Cyanobacteria  
Lichens  
Tardigrades  
Plant seeds






**LET'S LEARN TO SURVIVE ON EARTH, IN SPACE**



**AND EVENTUALLY ON OTHER WORLDS – THAT'S  
SUSTAINABILITY OF HUMANKIND!**



A photograph of an astronaut in a white spacesuit floating in space. The astronaut is wearing a helmet with a clear visor and has a Swedish flag patch on their right arm. They are holding a tool or device. In the background, the Earth's surface with clouds is visible. A white speech bubble is overlaid on the image, containing the text "Thank you for your attention!".

Thank you for your  
attention!

**Total log: 17.840.661 km**